

## UNIT - I

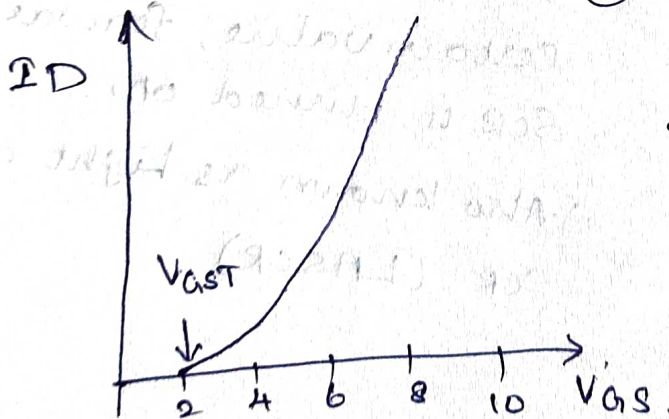
Two marks.

① What do you mean by Second Breakdown in Power BJT?

Secondary Breakdown is a failure mode in BJT. In a power transistor with a large Junction area, under certain conditions of current & voltage, the current concentrates in a small spot of the base-emitter junction. Secondary Breakdown is due to large power dissipation at localized site within the semiconductor.

② Define threshold voltage of Power MOSFET!

Threshold voltage is the voltage applied between gate and source of a MOSFET that is needed to turn the device on for linear and saturation regions of operation. When the voltage below threshold voltage  $V_{GS}$ , the device is off. It is of the order of 2 to 3 V.



③ Why TRIAC is not popular compared to SCR. Justify?

TRIAC has  
1) low  $dv/dt$  rating.  
2) Reliability is less.  
3) Careful about the triggering circuit as it can be triggered in either direction.

Transfer characteristics of MOSFET.

④ What are the advantages of IGBTs?  
1) simple drive circuit 2) low on-resistance 3) High voltage capacity. 4) Fast switching speed 5) Low switching loss  
b) low gate drive requirement.

① Define Holding current <sup>Two Marks.</sup> and Latching current in SCR.

Latching current :

The minimum forward anode current to maintain the thyristor in on state (causes the thyristor to initially latch from off state to on state and the gate signal is removed). This is usually higher than the holding current and is important because the gate pulse may be relatively short.

Holding current :

The minimum forward anode current to maintain thyristor in conduction state is called holding current. Below the holding current value thyristor is made off from on state.

② What is the purpose of using snubber circuit?

- i) Snubbers are circuits which are placed across semiconductor devices for protection and to improve performance.
- ii) snubber circuits are required to limit  $di/dt$ ,  $dv/dt$  and overvoltage during turn ON and turn OFF.

③ What are the advantages of GTO over SCR?

- i) A GTO is also a latching device that can be turned on by applying +ve gate pulse and turned off by applying -ve current pulse to gate.
- ii) GTO has the highest power rating and high blocking voltage
- iii) It has low conduction loss.

④ What are the Thyristor Turn-on methods :  
with anode positive with respect to cathode, a thyristor can be turned on by one or more of the following techniques :

- a) Forward voltage triggering
- b) Gate triggering
- c)  $dv/dt$  triggering
- d) Temperature triggering
- e) Light triggering.

⑤ What is meant by hard-firing or overdriving ?

When gate current is several times higher than the minimum gate current required, a thyristor is said to be hard-fired.

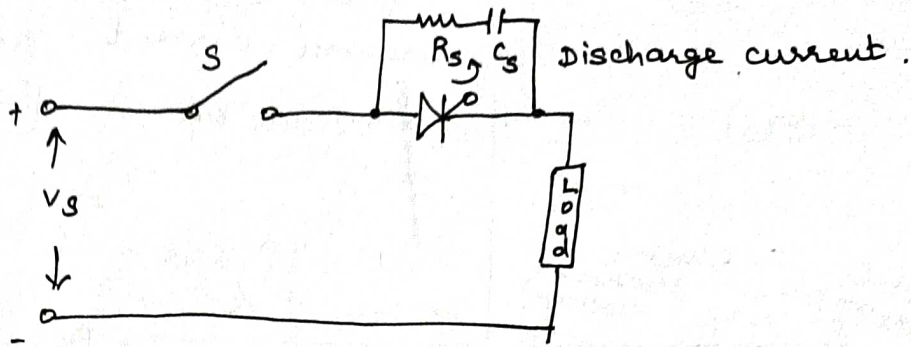
Hard firing of a thyristor reduces its turn-on time and enhances its  $di/dt$  capability.

⑥ What is meant by converter grade SCR and inverter grade SCRs?

Thyristors with slow turn-off time (50-100  $\mu$ sec) are called converter grade SCRs and those with fast turn-off time (3-50  $\mu$ sec) are called inverter grade SCR. Converter grade SCRs are cheaper and are used where slow turn off is possible as in phase controlled rectifiers, AC voltage controllers, Cycloconverters etc.

Inverter grade SCR are costlier and are used in inverters, choppers and force commutated converters.

⑦ Draw snubber circuit diagram :



snubber circuit consists of a series combination of Resistance  $R_s$  and capacitance  $C_s$  in parallel with the thyristor.

⑧ What are the application of GTOs :

GTO device are now being used in a) high performance drive systems such as rolling mills, robotics and machine tools b) traction purposes c) adjustable - frequency inverter drives.

⑨ what are the requirements to turn off the thyristor?

i) Anode current falls below the holding current.

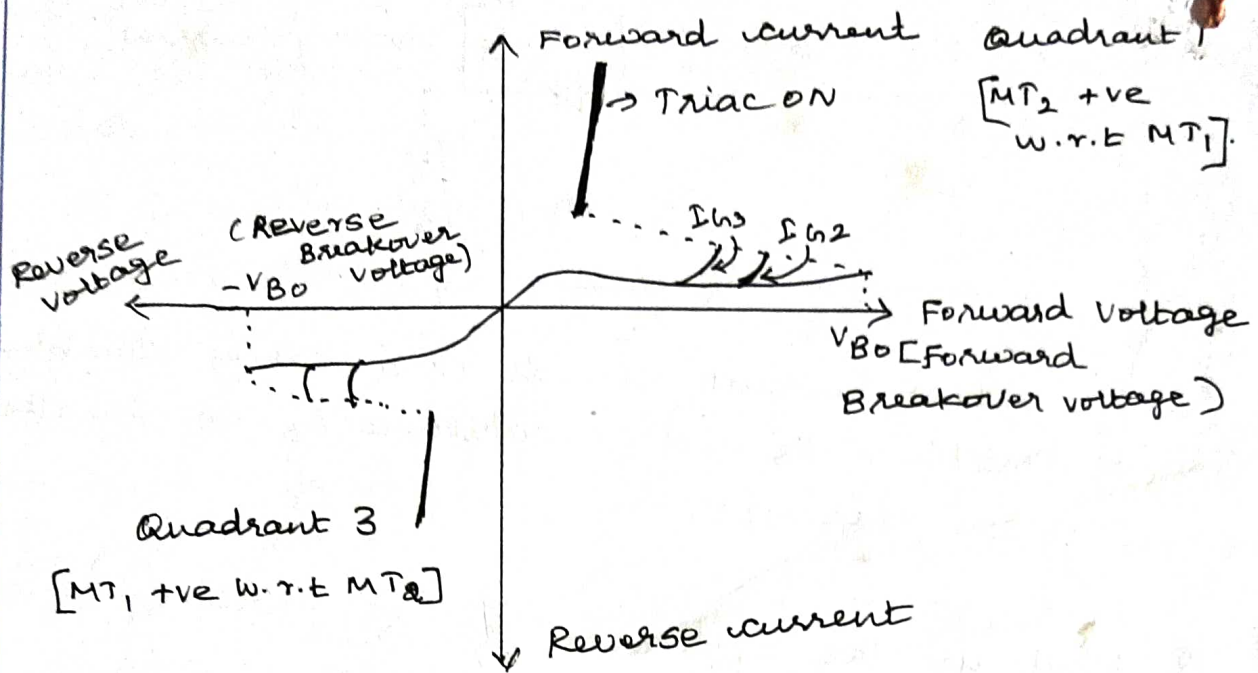
ii) Reverse voltage is applied to thyristor for a sufficient time to enable it to recover to blocking state.

⑩ what is meant by natural commutation?

When an SCR circuit is energised from ac source, current has to pass through its natural zero at the end of every positive half cycle.

Then ac source applies a reverse bias across it automatically, SCR is turned off. This is called natural (or) line commutation.

① Draw Triac characteristics:



② Compare power MOSFET and BJT:

Power MOSFET

BJT

- |   |  |
|---|--|
| ① PMOSFET is a unipolar device  | BJT is a bipolar device.                             |
| ② high input impedance  | low input impedance.                                 |
| ③ Low switching losses but on-resistance, conduction losses are more. | higher switching losses but lower conduction losses. |
| ④ Voltage controlled device   | current controlled device.                           |
| ⑤ positive temperature co-efficient                                   | Negative temperature co-efficient.                   |
| ⑥ secondary breakdown does not occur.                                 | secondary breakdown occurs.                          |
| ⑦ ratings are 500V, 140A  | 1200V, 800A.   |

UNIT-II (2 Marks).

① What is overlap angle (Nov/Dec 2015)

The period during which both the incoming and outgoing thyristors are conducting, is known as the overlap period. The angle for which both devices share conduction is known as the overlap angle ( $\mu$ ) or commutation angle.

② Mention some of the applications of converters (Nov/Dec 2015).

(i) DC motor control in steel mills, paper and textile mills employing dc motor drives.

(ii) Reactor controls

(iii) Portable hand tool drives.

(iv) AC fed traction system using dc traction motor.

③ Classify the different types of controlled rectifier: (Nov/Dec 2016).

(i)  $1\phi$  half wave controlled converter

(ii)  $1\phi$  semi converter.

(iii) single phase full converter.

(iv)  $3\phi$  half wave controlled converter.

(v)  $3\phi$  semi converter.

(vi)  $3\phi$  full converter.

④ What is the function of freewheeling diode and state its advantages : (Nov/Dec 2016)

(i) The continuous current will flow in the load after the SCR is turned off, due to the energy stored in the inductor.

(ii) The average value of the o/p voltage is same as that of with resistive load.

(iii) The converter has a better power factor due to this freewheeling action.

⑤ What is the effect of source impedance on the performance of converter? (Apr/May 2015)

(i) To lower the mean output voltage.

(ii) To distort the output voltage and current waveforms.

(iii) To modify the performance parameters of the converter.

⑥ Compare half controlled rectifier and full controlled rectifier :

Half controlled rectifier

i) It produces only one pulse during the cycle.

(ii) consists of both thyristor and diodes. It rectify only half of the wave.

Full controlled rectifier

i) It produces two pulses during the cycle.

consists of two thyristor and rectify both part of waveform.

⑦ What is meant by forced commutation?

In case of d.c circuits, for switching off thyristors, the forward current of the thyristor is forced to zero, by an additional circuit called commutation circuit. This is called forced commutation.

⑧ What is meant by firing angle (or) delay angle?

The angle between the zero crossing of the input voltage and the instant the thyristor is fired.

⑨ What are the advantages of 6 pulse converter?

(i) Commutation is made simple.

(ii) Distortion on the ac side is reduced due to the reduction in lower order harmonics.

⑩ What is meant by input power factor in controlled Rectifier?

It is defined as the ratio of the total mean input power to the total RMS input volt-amperes.

⑪ Define Pulse number?

Pulse number is defined as the number of pulses in the d.c output voltage within one time period of the ac source voltage. For e.g. 1 $\phi$  half controlled rectifier produce only one pulse of load current during one cycle of source voltage, it can be termed as 1 $\phi$  one pulse converters.



12) Define Input power factor :-

It is defined as the ratio of the total mean input power to the total RMS input volt-ampere.

$$P.F = \frac{E_1 I_1 \cos \phi_1}{E_{rms} I_{rms}}$$

13) what is meant by commutation of SCR and its types.

A thyristor is turned on by applying a signal to its gate-cathode circuit. Commutation means a process of turning off a thyristor.

Types :-

- 1) Load commutation
- 2) Resonant pulse commutation
- 3) Impulse commutation
- 4) External pulse commutation
- 5) Line commutation.

14) Write the relation between firing angle and extinction angle in  $1\phi$  fully controlled rectifier when operating with RL load!

$\alpha \rightarrow$  firing angle.

$\beta \rightarrow$  extinction angle.

$\gamma \rightarrow$  conduction angle.

$$\boxed{(\beta - \alpha) = \gamma}$$

$$v_T = v_m \sin \alpha,$$

$$v_T = v_m \sin \beta; \beta > \pi, v_T \text{ is negative at } \omega t = \beta.$$

Thyristor reverse biased from  $\omega t = \beta$  to  $2\pi$ .

15) what is meant by phase control ?

The firing angle is defined as the angle between the zero crossing of the input voltage and the instant the thyristor is fired. The most efficient method to control the turning ON of a thyristor is achieved by varying the firing angle of SCR.

A thyristor is a four-layer semiconductor device consisting of alternating layers of P and N material. It has a P-N-P-N structure. The first P-layer is the anode, the first N-layer is the cathode, and the second P-layer is the gate. The second N-layer is the drift region. The thyristor is normally in a non-conducting state. It starts to conduct when the anode-cathode voltage is high enough to cause a large number of minority carriers to be injected into the drift region. This causes a regenerative feedback process, and the thyristor turns on. The firing angle is the angle between the zero crossing of the input voltage and the instant the thyristor is fired. The most efficient method to control the turning ON of a thyristor is achieved by varying the firing angle of SCR.

Types of thyristors:

- 1) Load commutation
- 2) Resonant pulse commutation
- 3) Impulse commutation
- 4) Self commutation
- 5) Line commutation

(ii) The relation between firing angle and average output voltage is given by the following equation:

$$V_o = \frac{V_m}{\pi} [1 + \cos \alpha]$$

where  $V_o$  is the average output voltage,  $V_m$  is the peak value of the input voltage, and  $\alpha$  is the firing angle.

Two marks.

①. What are the advantages and disadvantages of resonant pulse converter?

Advantages:-

① switching losses are less, ② less electromagnetic interference ③ operating switching frequency is high ④  $\eta$  is high

Disadvantages:-

① Limited frequency, ② large size ③ heavy weight.

② What is meant by resonant converter?

The switching devices are turned on and off when the voltage across a device or its current become zero, is known as resonant converter. They are used to reduce the switches subjected to high voltage stress and reduce the switching losses.

③ write applications of d-c chopper?

- 1) Battery operated vehicles
- 2) Traction motor control
- 3) Trolley cars
- 4) Marine hoists
- 5) Electric Braking.
- 6) Mine haulers.

### UNIT-3

① A step up chopper is operated with a duty ratio of 0.6 for a d.c input of 100V. Determine the output voltage for a load resistance of  $R_L = 5\Omega$ .

$$V_o = \frac{V_s}{1-d}$$

$$V_s = 100V, \quad d = 0.6$$

$$V_o = \frac{100}{1-0.6} = \frac{100}{0.4} = 250V$$

②. What are the main difference between voltage source and current source Inverters?

#### Voltage source Inverter (VSI)

- 1) Input voltage is maintained constant
- 2) It requires feed back diodes
- 3) The output voltage does not depend on the load.
- 4) The magnitude of the output current & its waveform depends on the nature of load impedance.

#### Current source Inverter (CSI)

- Input current is constant but Adjustable.
- It does not require feed back diodes.
- The output current does not depend on the load.
- The magnitude of output voltage and its waveform depends on the nature of the load impedance.

③ Name the two types of control strategies available for d.c choppers:

- i) Time Ratio control (TRC).
  - a) constant frequency control.
  - b) variable frequency control.
- ii) current limit control (CLC).

④ Define duty cycle in d.c chopper :

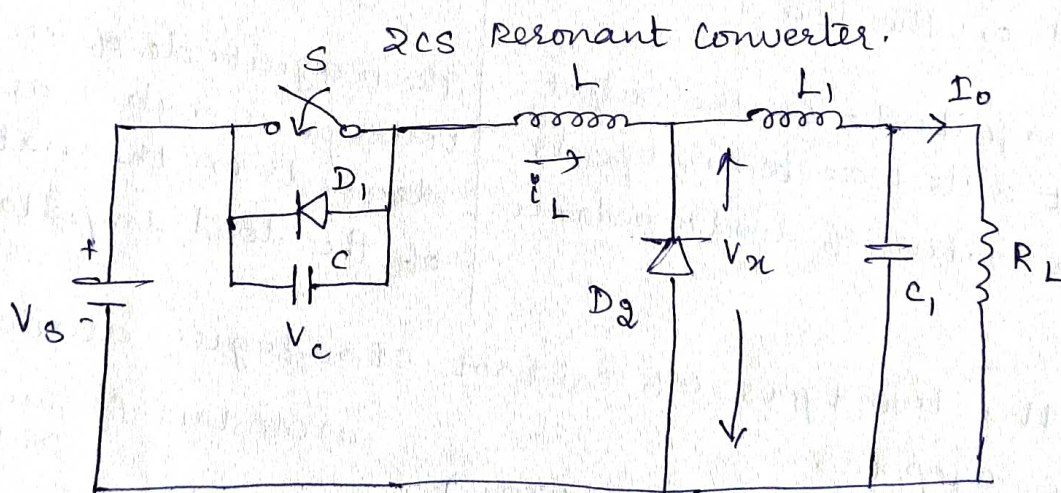
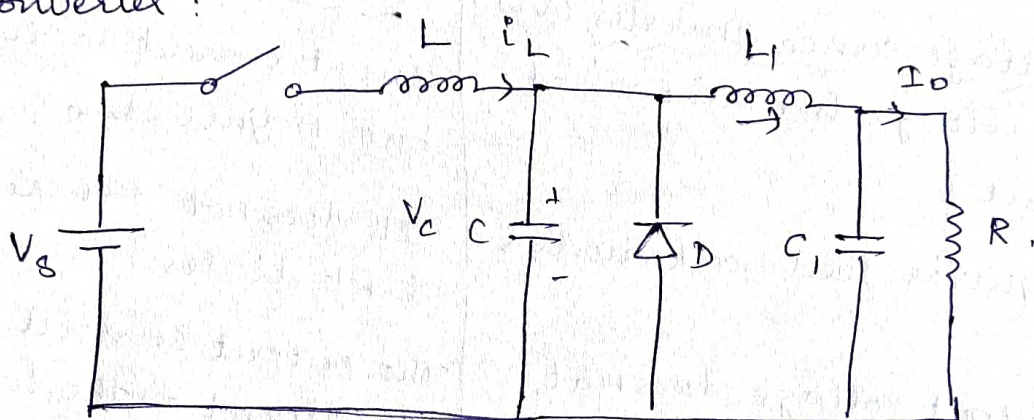
Duty cycle is defined as the ratio of the ON time of the chopper to the total time period of the chopper. It is denoted by  $d$ .

$$d = \frac{T_{on}}{T}$$

⑤. List the use of class B chopper ?

i) class B chopper can be employed for the regenerative braking of d.c motors. Power flows from load to source.

⑥. Draw the circuit diagram of ZCS & ZVS Resonant converter :



ZVS Resonant Converter.

## UNIT-III DC TO DC CONVERTER

### Two Marks :

1. **What are the two types of control strategies?**

a. Time Ratio Control (TRC) b. Current Limit Control method (CLC)

2. **What is meant by TRC?**

In TRC, the value of  $T_{on} / T$  is varied in order to change the average output voltage.

3. **What are the two types of TRC?**

a. Constant frequency control b. Variable frequency control

4. **What is meant by FM control in a dc chopper?**

In frequency modulation control, the chopping frequency  $f$  (or the chopping period  $T$ ) is varied. Here two controls are possible. a. On-time  $T_{on}$  is kept constant b. Off period  $T_{off}$  is kept constant.

5. **What is meant by PWM control in dc chopper?**

In this control method, the on time  $T_{on}$  is varied but chopping frequency is kept constant. The width of the pulse is varied and hence this type of control is known as Pulse Width Modulation (PWM).

6. **Write down the expression for the average output voltage for step down and step up chopper.**

Average output voltage for step down chopper is  $V_O = VS$ . Average output voltage for step up chopper is  $V_O = VS \times [1 / (-1)]$ .

7. **What are the different types of chopper with respect to commutation process?**

a. Voltage commutated chopper. b. Current commutated chopper. c. Load commutated chopper.

8. **What is meant by voltage commutation?**

In this process, a charged capacitor momentarily reverse biases the conducting thyristor and turn it off.

9. **What is meant by current commutation?**

In this process, a current pulse is made to flow in the reverse direction through the conducting thyristor and when the net thyristor current becomes zero, it is turned off.

10. **What is meant by load commutation?**

In this process, the load current flowing through the thyristor either becomes zero or is transferred to another device from the conducting thyristor.

**11. What are the advantages of current commutated chopper?**

a. The capacitor always remains charged with the correct polarity. b. Commutation is reliable as load current is less than the peak commutation current ICP. c. The auxiliary thyristor TA is naturally commutated as its current passes through zero value.

**12. What are the advantages of load commutated chopper?**

a. Commutating inductor is not required. b. It is capable of commutating any amount of load current. c. It can work at high frequencies in the order of kHz. d. Filtering requirements are minimal.

**13. What are the disadvantages of load commutated chopper?**

a. For high power applications, efficiency becomes very low because of high switching losses at high operating frequencies. b. Freewheeling diode is subjected to twice the supply voltage. c. Peak load voltage is equal to twice the supply voltage. d. The commutating capacitor has to carry full load current at a frequency of half chopping frequency. e. One thyristor pair should be turned-on only when the other pair is commutated. This can be realized by sensing the capacitor current that is alternating.

**14. What is meant by inverter?**

A device that converts dc power into ac power at desired output voltage and frequency is called an inverter.

**15. What are the applications of an inverter?**

a. Adjustable speed drives b. Induction heating c. Stand-by aircraft power supplies d. UPS e. HVDC transmission

**16. What are the main classification of inverter?**

a. Voltage Source Inverter b. Current Source Inverter

**17. Why thyristors are not preferred for inverters?**

Thyristors require extra commutation circuits for turn off which results in increased complexity of the circuit. For these reasons thyristors are not preferred for inverters.

**18. How output frequency is varied in case of a thyristor?**

The output frequency is varied by varying the turn off time of the thyristors in the inverter circuit, i.e. the delay angle of the thyristors is varied.

**19. Give two advantages of CSI.**

a. CSI does not require any feedback diodes. b. Commutation circuit is simple as it involves only thyristors.

**20. What is the main drawback of a single phase half bridge inverter?**

It requires a 3-wire dc supply.

① compare CSI and VSI

CSI

VSI

① Most commonly used for synchronous motor control

Most commonly used for Induction Motor control.

② Peak current rating is smaller

Peak current rating is higher.

③ Response time is less

good response time.

② what is duty cycle?

duty cycle can be produced by the comparison of d.c reference signal with the carrier signal.

$V_{ref}$   $\rightarrow$  amplitude of dc reference signal

$V_c$   $\rightarrow$  amplitude of carrier signal.

$$S = \frac{V_{ref}}{V_c}$$

The ratio of the reference signal to carrier signal gives the modulation index.

③ Why thyristors are not preferred for Inverter?  
Thyristors require extra commutation circuit for turn off which result in increased complexity of the circuit. For this reason thyristors are not preferred for inverters.

④ what is a matrix converter?

Converters built on the bi-directional, bipolar switches are called matrix converters. They provide a direct power flowing between n-phase ac source and m-phase load.



⑤ what are the disadvantages of the harmonics present in the inverter system?

i) The output voltage and waveform becomes distorted one.

ii) Switching losses is increased.

⑥ what are the possible methods to control a.c output voltage.

i) AC voltage control.

ii) series - inverter control.

## UNIT-IV INVERTERS

### 1. Why diodes should be connected in antiparallel with the thyristors in inverter circuits?

For RL loads, load current will not be in phase with load voltage and the diodes connected in anti parallel will allow the current to flow when the main thyristors are turned off. These diodes are called feedback diodes.

### 2. What types of inverters require feedback diodes?

VSI with RL load

### 3. What is meant a series inverter?

An inverter in which the commutating elements are connected in series with the load is called a series inverter.

### 4. What is the condition to be satisfied in the selection of L and C in a series inverter?

$$R^2 < 4L$$

### 5. What is meant a parallel inverter?

An inverter in which the commutating elements are connected in parallel with the load is called a parallel inverter.

### 6. What are the applications of a series inverter?

The thyristorised series inverter produces an approximately sinusoidal waveform at a high output frequency, ranging from 200 Hz to 100kHz. It is commonly used for fixed output applications such as a. Ultrasonic generator. b. Induction heating. c. Sonar Transmitter d. Fluorescent lighting.

### 7. How is the inverter circuit classified based on commutation circuitry?

a. Line commutated inverters. b. Load commutated inverters. c. Self commutated inverters. d. Forced commutated inverters.

### 8. What is meant by McMurray inverter?

It is an impulse commutated inverter which relies on LC circuit and an auxiliary thyristor for commutation in the load circuit.

### 9. What are the applications of a CSI?

a. Induction heating b. Lagging VAR compensation c. Speed control of ac motors d. Synchronous motor starting.

### 10. What is meant by PWM control?

In this method, a fixed dc input voltage is given to the inverter and a controlled ac

output voltage is obtained by adjusting the on and off periods of the inverter components. This is the most popular method of controlling the output voltage and this method is termed as PWM control .

**11. What are the advantages of PWM control?**

- a. The output voltage can be obtained without any additional components.
- b. Lower order harmonics can be eliminated or minimized along with its output voltage control. As the higher order harmonics can be filtered easily, the filtering requirements are minimized.

**12. What are the disadvantages of the harmonics present in the inverter system?**

- a. Harmonic currents will lead to excessive heating in the induction motors. This will reduce the load carrying capacity of the motor.
- b. If the control and the regulating circuits are not properly shielded, harmonics from power ride can affect their operation and malfunctioning can result.
- c. Harmonic currents cause losses in the ac system and can even some time produce resonance in the system. Under resonant conditions, the instrumentation and metering can be affected.
- d. On critical loads, torque pulsation produced by the harmonic current can be useful.

**13. What are the methods of reduction of harmonic content?**

- a. Transformer connections
- b. Sinusoidal PWM
- c. Multiple commutation in each cycle
- d. Stepped wave inverters

**15. What are the disadvantages of PWM control?**

SCRs are expensive as they must possess low turn-on and turn-off times.

**16. What does ac voltage controller mean?**

It is device which converts fixed alternating voltage into a variable voltage without change in frequency.

**17. What are the applications of ac voltage controllers?**

- a. Domestic and industrial heating
- b. Lighting control
- c. Speed control of single phase and three phase ac motors
- d. Transformer tap changing

**18. What are the advantages of ac voltage controllers?**

- a. High efficiency
- b. Flexibility in control
- c. Less maintenance

**19. What are the disadvantages of ac voltage controllers?**

The main draw back is the introduction of harmonics in the supply current and the load voltage waveforms particularly at low output voltages .

**20. What are the two methods of control in ac voltage controllers?**

- a. ON-OFF control
- b. Phase control

## UNIT - IV

① Why the THD has to be mitigated?

- ① To improve power factor and reduce system loss.
- ② Minimise interference with other equipment.
- ③ To improve system voltage/current waveform.
- ④ To prevent nuisance tripping of fuse and circuit breakers.

②. What are the purposes of free back diodes in Inverters  
For inductive load, current  $i_o$  will not be in phase with voltage  $V_o$  and diodes connected in antiparallel with thyristors will allow the current to flow when the main thyristors are turned off. These diodes are called free back diodes.

③. Mention the PWM methods in Inverters.

- i) Single pulse modulation.
- ii) Multiple pulse modulation.
- iii) Sinusoidal pulse modulation.
- iv) Modified sinusoidal pulse width modulation.

④. What are the advantages and disadvantages of resonant pulse converter?

### Advantages :-

- i) Switching losses are less.
- ii) Less electromagnetic interference.
- iii) Operating switching frequency is high.
- iv) Efficiency is high.

### Disadvantages :

- 1) Limited frequency.
- 2) Larger size.
- 3) Heavy weight.
- 4) Power dissipation may occur in any working condition.

## UNIT-V AC TO AC CONVERTERS

### 1. What is the difference between ON-OFF control and phase control?

ON-OFF control: In this method, the thyristors are employed as switches to connect the load circuit to the source for a few cycles of the load voltage and disconnect it for another few cycles.

Phase control: In this method, thyristor switches connect the load to the ac source for a portion of each half cycle of input voltage.

### 2. What is the advantage of ON-OFF control?

Due to zero-voltage and zero current switching of thyristors, the harmonics generated by the switching action are reduced.

### 3. What is the disadvantage of ON-OFF control?

This type of control is applicable in systems that have high mechanical inertia and high thermal time constant.

### 4. What is the duty cycle in ON-OFF control method?

Duty cycle  $K = n / (n + m)$ ,

where  $n =$  no. of ON cycles,  $m =$  no. of OFF cycles.

### 5. What is meant by unidirectional or half-wave ac voltage controller?

Here the power flow is controlled only during the positive half-cycle of the input voltage.

### 6. What are the disadvantages of unidirectional or half-wave ac voltage controller?

a. Due to the presence of diode on the circuit, the control range is limited and the effective RMS output voltage can be varied between 70.7% and 100%.

b. The input current and output voltage are asymmetrical and contain a dc component. If there is an input transformer, saturation problem will occur

c. It is only used for low power resistive load.

### 7. What is meant by bidirectional or half-wave ac voltage controller?

Here the power flow is controlled during both cycles of the input voltage.

### 8. What is the control range of firing angle in ac voltage controller with RL load?

The control range is  $F < \alpha < 180^\circ$ , where  $F =$  load power factor angle.

### 9. What type of gating signal is used in single phase ac voltage controller with RL load?

High frequency carrier gating signal is used for single phase ac voltage controller with RL load.

Q8) what is a matrix converter  
Matrix converter is a capable of direct conversion from AC to AC by using bidirectional bulky controlled switches.

10. What are the disadvantages of continuous gating signal?

a. More heating of the SCR gate. b. Increases the size of pulse transformer.

11. What is meant by high frequency carrier gating?

Thyristor is turned on by using a train of pulses from a to p. This type of signal is called as high frequency carrier gating.

12. What is meant by sequence control of ac voltage regulators?

It means that the stages of voltage controllers in parallel triggered in a proper sequence one after the other so as to obtain a variable output with low harmonic content.

13. What are the advantages of sequence control of ac voltage regulators?

a. System power factor is improved. b. Harmonics are reduced in the source current and the load voltage.

14. What is meant by cyclo-converter?

It converts input power at one frequency to output power at another frequency with one-stage conversion. Cycloconverter is also known as frequency changer.

15. What are the two types of cyclo-converters?

a. Step-up cyclo-converters b. Step-down cyclo-converters

16. What is meant by step-up cyclo-converters?

In these converters, the output frequency is less than the supply frequency.

17. What is meant by step-down cyclo-converters?

In these converters, the output frequency is more than the supply frequency.

18. What are the applications of cyclo-converter?

a. Induction heating b. Speed control of high power ac drives c. Static VAR generation d. Power supply in aircraft or ship boards

19. What is meant by positive converter group in a cyclo converter?

The part of the cyclo converter circuit that permits the flow of current during Positive half cycle of output current is called positive converter group.

20. What is meant by negative converter group in a cyclo converter?

The part of the cyclo converter circuit that permits the flow of current during negative half cycle of output current is called negative converter group.

21) Give the demerits of cycloconverter :

- 1) control circuit become complex.
- 2) power factor is poor.
- 3) output frequency is  $\frac{1}{3}$ th or  $\frac{1}{2}$ th for desirable power output and efficiency.